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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/087,510

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Sethuraman Jayashankar

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07/02/2004

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EXAMINER

AHMED, SHAMIM

ART UNIT

PAPER NUMBER

1765

DATE MAILED: 07/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

### Application No.

10/087,510

### Applicant(s)

JAYASHANKAR ET AL

### Examiner

Shamim Ahmed

### Art Unit

1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 30 April 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-12 and 16-28 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,2,5-9,12,16-22 and 25-28 is/are rejected.
- 7) ☒ Claim(s) 3,4,10,11,23 and 24 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

### *Response to Arguments*

1. Applicant's arguments with respect to claim 1, regarding the limitation of "applying megasonic energy to the substrate via a thin meniscus of lift-off fluid" have been considered but are moot in view of the new ground(s) of rejection.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).
4. Claims 1 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsuge et al (4,548,834) as supported by Penny (4,687,541) in view of Akatsu et al (6,021,789).

Tsuge et al disclose a photoresist lift-off process, wherein a dielectric layer (14) is deposited on a substrate (11) and a photoresist (13), which is covering at least a portion of the substrate (col.4, lines 9-22, lines 49-56).

Tsuge et al remain silent or may be explicitly do not show that the dielectric layer is deposited on a side of said photoresist but the dielectric layer is conventionally formed on the sidewall of the photoresist during the deposition on the top surface of the photoresist and the substrate as evidenced by Penney (col.3, lines 49-65 and figure 3).

Tsuge et al also disclose that an ultrasonic energy or treatment is applied to the lift-off fluid in order to dissolve or remove the photoresist (col.4, lines 53-61).

Tsuge et al fail to disclose that the energy applied to crack the sidewall dielectric is megasonic.

However, in a method of cleaning unwanted materials from a substrate during the processes routinely used in the manufacturing of integrated circuits, Akatsu et al teach an improved megasonic cleaning process, wherein the megasonic transducers being capable of operating at megasonic frequencies and being sufficiently proximate such as a progressive wave formed in the liquid near the exposed surface, which reads on the claimed limitation of "applying megasonic energy to said substrate surface via a thin meniscus of lift-off fluid" (col.1, lines 15-30, lines 55-62 and col. 2, lines 7-12).

Akatsu et al teaches that the transducers are capable of operating at megasonic frequencies (0.8-6 MHz) in order to remove the unwanted material from the substrate surface (col.4, lines 4-12).

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Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Akatsu et al's teaching of introduction of prograssive megasonic wave near the exposed surface into Tsuge et al' process because Tsuge et al's ultrasonic treatment will broadly includes the ultrasonic vibration (0.2- 5 MHz) having megasonic energy for efficient removal of photoresist as taught by Akatsu et al.

Furthermore, one of ordinary skilled in the art would have been motivated to apply ultrasonic vibration with higher value of the broad range of 0.2-5 MHz as taught by Akatsu et al because higher vibration frequency will provide enough energy that will easily remove the photoresist and would crack or break the sidewall dielectric because without breaking or rupturing the sidewall deposition, it is not possible to remove the photoresist.

5. Claims 2,5-9,12,17-22, 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsuge et al (4,548,834) as supported by Penny (4,687,541) in view of Akatsu et al (6,021,789) as applied to claims1and 16 above, and further in view of Hackenberg (6,526,995).

As to claims 2 and 21, Modified Tsuge et al discussed above in the paragraph 4 but fail to disclose the introduction of a surfactant to the lift-off fluid.

However, in a wafer cleaning process, Hackenberg teaches that surfactants may also be added during the megasonic cleaning for reducing the interfacial tension between a liquid and a solid (col.2, lines 49-54).

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Hackenberg's teaching into modified Tsuge et al's process for increasing photoresist removal rate by reducing the interfacial tension between the removal liquid and the photoresist (solid) as taught by Hackenberg.

As to claims 6-7 and 17-22 and 28, Modified Tsuge et al also do not disclose that the lift-off fluid is formulated in such that repulsive Van der Waals forces are created between the photoresist and the substrate.

However, Hackenberg also teaches that pH of the megasonic baths are controlled in such as way that will break the weak forces such as Van der Waals or electrostatic forces between the substrate and the contamination or the material to be removed or cleaned (col.3, lines 35-46) and such teaching reads on applicant's limitation of creating repulsive Van der Waals forces between the photoresist and the substrate surface.

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Hackenberg's teaching into modified Tsuge et al's process for easily removing the photoresist from the substrate by adjusting the pH in order to improve the efficiency of breaking the forces holding the contamination to the substrate to be cleaned as taught by Hackenberg.

As to claims 9 and 25, it would have been obvious that the pH adjustment taught by Hackenberg will create the same repulsive Van der Waals forces between the photoresist and the metal feature because Tsuge et al teach that a metal feature (12) is

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provided intermediate the substrate (11) and the photoresist is on the metal feature (col.4, lines 27-28 and figures 1B-1E).

As to claims 5 and 19, Tsuge et al teach that the photoresist is removed by dissolving in lift-off fluid such as acetone with ultrasonic treatment (col.4, lines 53-61).

Therefore, it would have been obvious that the photoresist is chemically reactive with the lift-off fluid because without chemically reacting, it is not possible to dissolve the photoresist.

As to claims 8 and 20, Hackenberg teaches that the megasonic cleaning bath includes etching solution such as oxidizer, which will oxidize the photoresist to enhance the removal process (col. 5, lines 1-8).

As to claim 12, Hackenberg teaches that the megasonic cleaning uses higher frequencies at 700-1000 kHz for providing a controlled cavitation, which broadly teaches the megasonic energy comprises pulsing the energy on and off in order to control the cavitation (col.1, lines 59-63).

As to claim 18, Hackenberg teaches that the pH of the megasonic cleaning bath is adjusted by adding an alkali or a base in order to increase the cleaning efficiency (col.5, lines 15-19).

As to claim 27, wherein the claim is treated, as the acoustic energy is further comprises two or more times of megasonic energy is applied since there is a lack of antecedent basis for the ultrasonic energy.

As to the above claim, Hackenberg teaches that substrate can be treated at least two or more chemical megasonic baths for short duration for increasing cleaning

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efficiency and also for increasing the life of the chemical bath (col.3, lines 1-9 and lines 30-34).

Therefore, it would have been obvious to one of ordinary skilled in the art at the time of claimed invention to combine Hackenberg's teaching into modified Tsuge et al's process for increasing cleaning efficiency and also for increasing the life of the chemical bath as taught by Hackenberg.

### ***Allowable Subject Matter***

6. Claims 3-4,10-11 and 23-24 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

7. The following is a statement of reasons for the indication of allowable subject matter: The prior art does not teach or suggest the application of ultrasonication to the substrate subsequent to applying the megasonic energy as the context of claims 3 and 23.

The prior art also does not teach or suggest reducing a thickness of the sidewall dielectric prior to applying the megasonic energy as the context of claim 10.

### ***Conclusion***

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shamim Ahmed whose telephone number is (571) 272-1457. The examiner can normally be reached on M-Thu (7:00-5:30) Every Friday Off.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine G Norton can be reached on (571) 272-1465. The fax phone



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number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Shamim Ahmed  
Examiner  
Art Unit 1765

SA  
June 28, 2004